

NANORACKS

ISS CUBESAT DEPLOYMENT

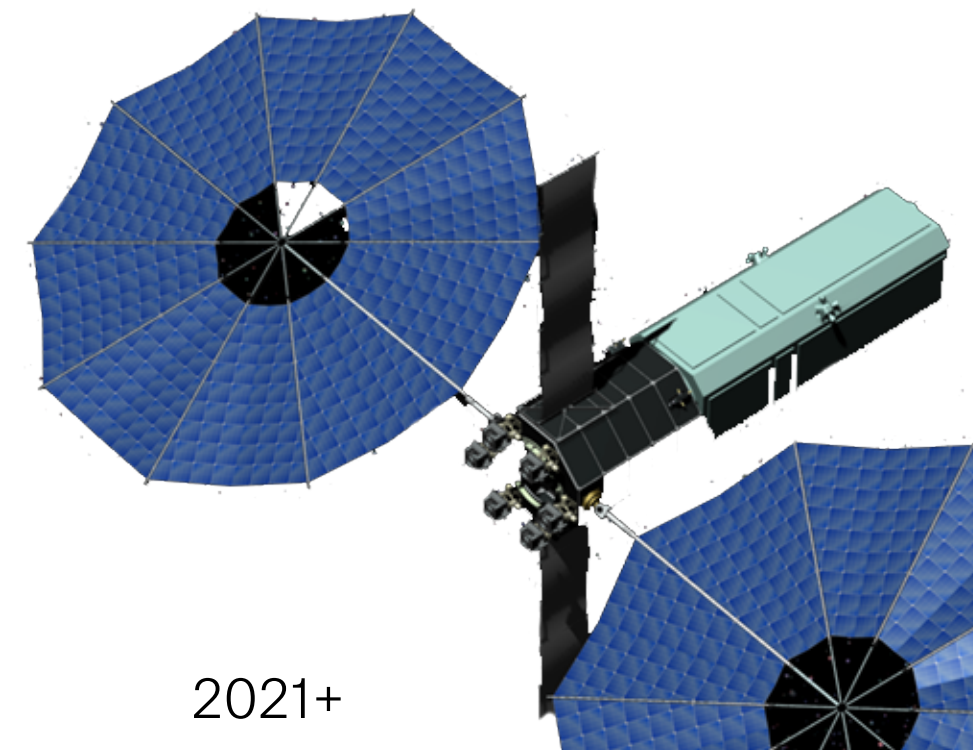
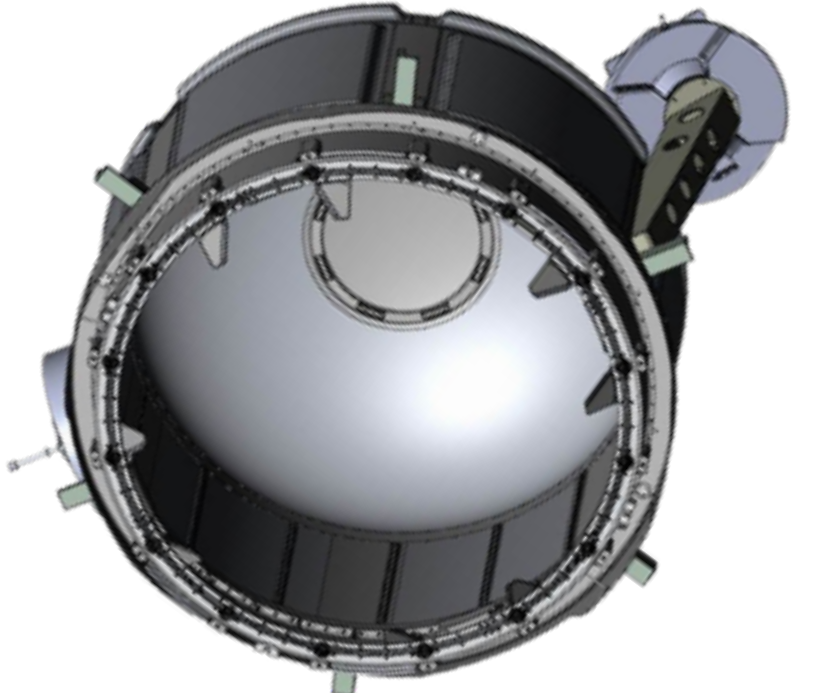
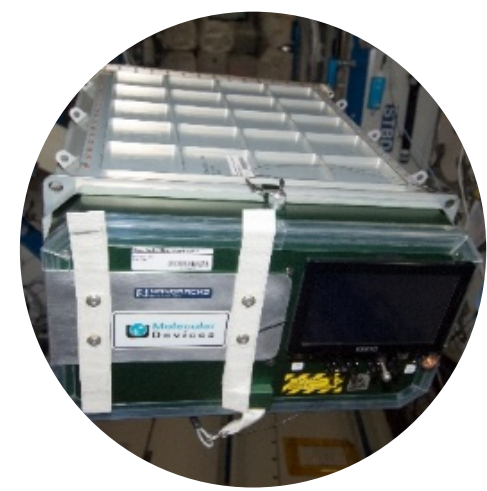
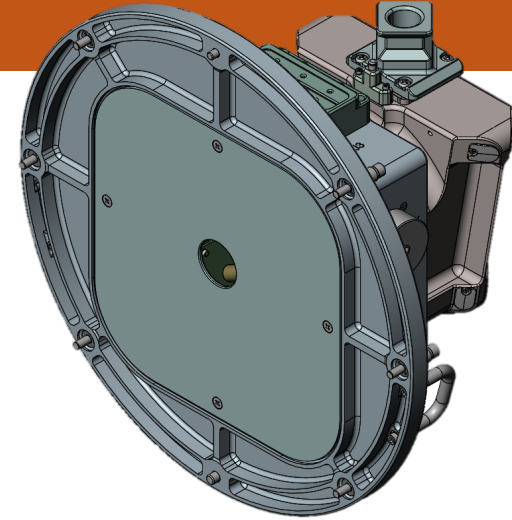
NanoRacks is the proven leader of CubeSat deployment from the International Space Station, having deployed over 90 CubeSats to date, with a full pipeline intact. Now displaying new capabilities on the Cygnus spacecraft, NanoRacks is continuing to grow as the customer-choice for LEO CubeSat deployment.

**CubeSat Developers Workshop
San Luis Obispo, 2016**

Henry Martin: hmartin@nanoracks.com



EVOLUTION OF NANORACKS HARDWARE AND CUSTOMER BASE



**CUBESAT
DEPLOYMENT**

**MICROSAT
DEPLOYMENT**

**EXTERNAL
PLATFORM**

**EARTH
OBSERVATION**

**COMMERCIAL
RESEARCH PLATFORM**

Domestic and Foreign
Industry

**MICROPLATE READER &
BIOPHARMA**

Commercial and government
organizations worldwide

**COMMERCIAL
AIRLOCK**

Commercial researchers

Space Station Operation System, Free Flyers,
Commercial Modules, Commercial Space Stations

MIXSTIX

**COMMERCIAL
PLATFORMS
AND STATIONS**

Privately owned microgravity
research equipment

NANOLAB

2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021+

NANORACKS CUSTOMERS AROUND THE WORLD



ISS OPPORTUNITIES

SMALLSAT DEPLOYMENT SERVICES

OUR CURRENT SERVICES INCLUDE satellite deployment, biopharma services, test platforms for advanced earth observation sensors, materials and educational research platforms—wherever there is a need for space goods or services, NanoRacks is part of the commercial solution.

NANORACKS CUBESAT DEPLOYER (NRCSD)

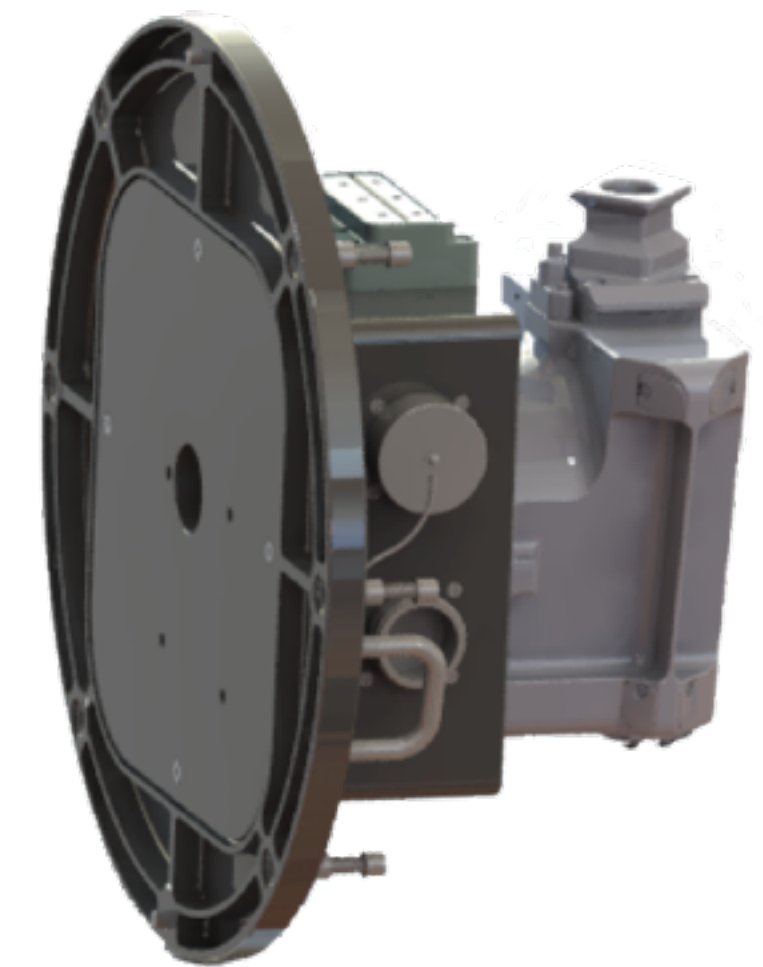
- Low-cost deployment system using Japanese module on ISS
- Deployed more satellites in the last 2 years than any other launch service provider
- Each NRCSD can deploy up to 6U of CubeSats
- 8 NRCSD's per airlock cycle, for a total of 48U deployment capability
- Flight heritage with wide variety of COTS CubeSat components:
 - Clyde Space
 - GomSpace
 - Pumpkin
 - ISIS



- 51.6 degree inclination, 385-415 KM
- Orbit lifetime 6-12 months
- Deployment typically 1-3 months after berthing
- Soft stowage internal ride several times per year

KABER SMALL SATELLITE DEPLOYER

- New Kaber deployer to deploy medium 50 kg to 82 kg satellites
- Size favored by NASA, Air Force, and other high-value customers
- NanoRacks Separation System
- Launched via pressurized cargo resupply vehicle to the International Space Station



EXTERNAL CYGNUS

NANORACKS CUBESAT DEPLOYMENT

EXTERNAL CYGNUS DEPLOYMENT

- Launched on OA-6 in March 2016
- Payloads on the exterior of the Cygnus vehicle
- Cygnus will deploy CubeSats after departing ISS
- Inclination of 51.6 degrees
- NanoRacks CubeSat Deployer
 - Panel 5 of Cygnus Service Module
 - 2x3 array of 6U deployers (36U total)
- Planned missions on OA-5, OA-7, OA-8

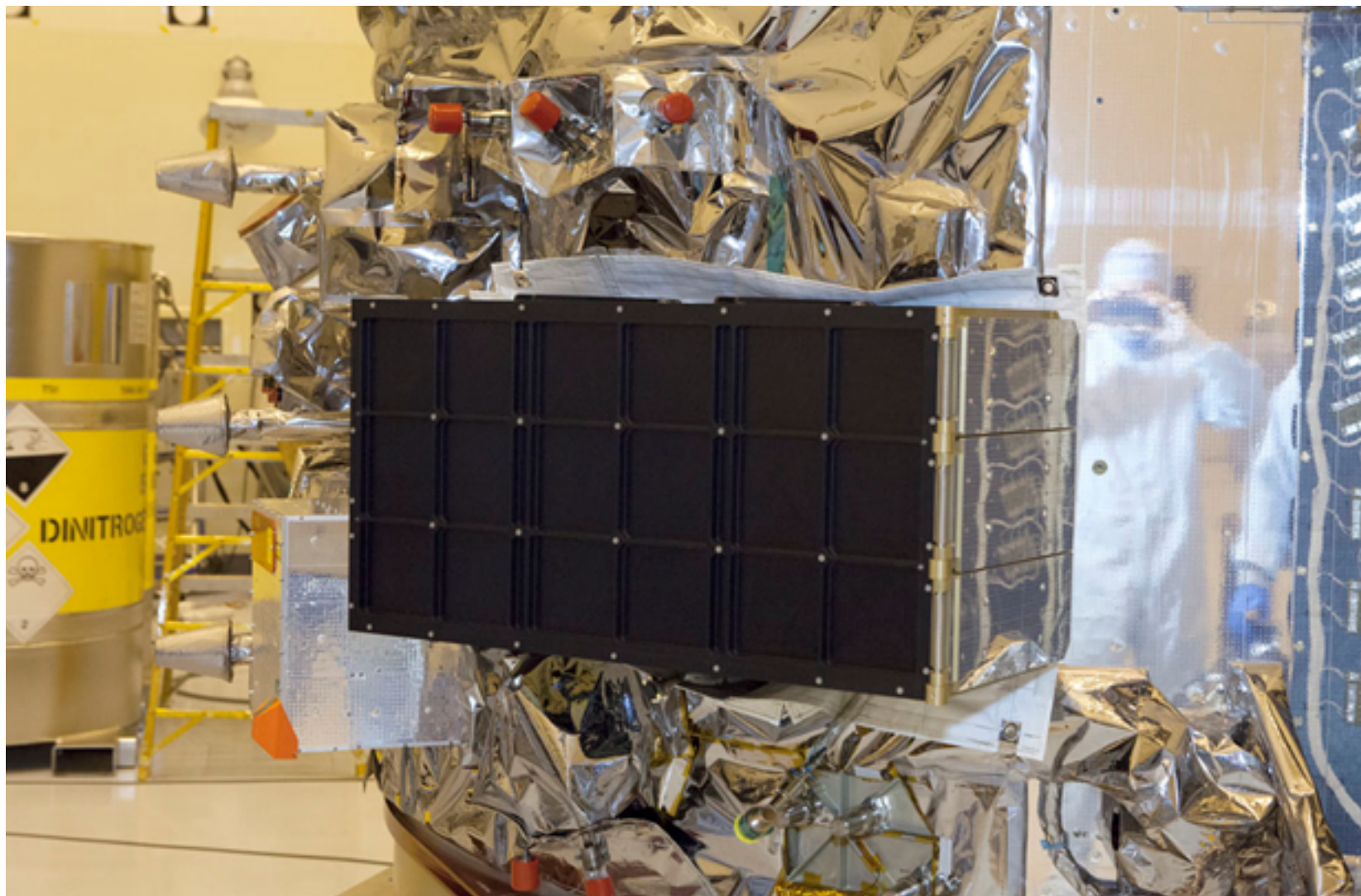


EXTERNAL CYGNUS, CONT.

NANORACKS CUBESAT DEPLOYMENT

EXTERNAL DEPLOYMENT

- Identical mechanical interface as the NanoRacks CubeSat Deployer that operates via the JEM airlock on Station
- Two fault tolerant release mechanism
- Installed post-fueling of Cygnus Service Module
 - Occurs around L-20 to 40 days

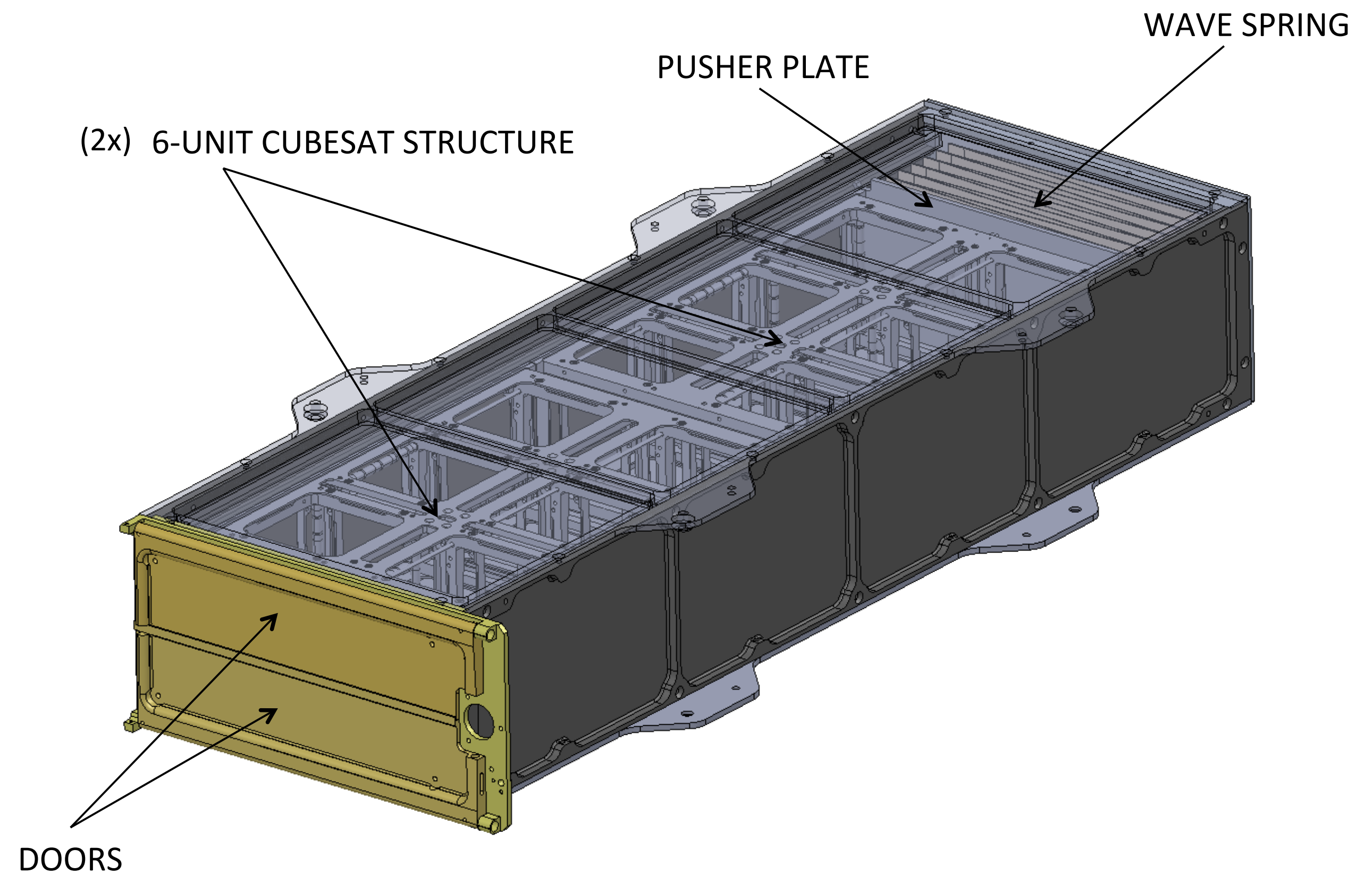


THE DOUBLEWIDE DEPLOYER

GROW YOUR CUBESAT

BUILDING ON EXISTING PLATFORMS

- NanoRacks developing deployer capable of accommodating traditional 6U form factor, optimized for use on ISS
- Design compatible with JEM airlock slide table and existing NRCSDs
- Target launch Q2 2017



NANORACKS EXTERNAL PLATFORM

NREP

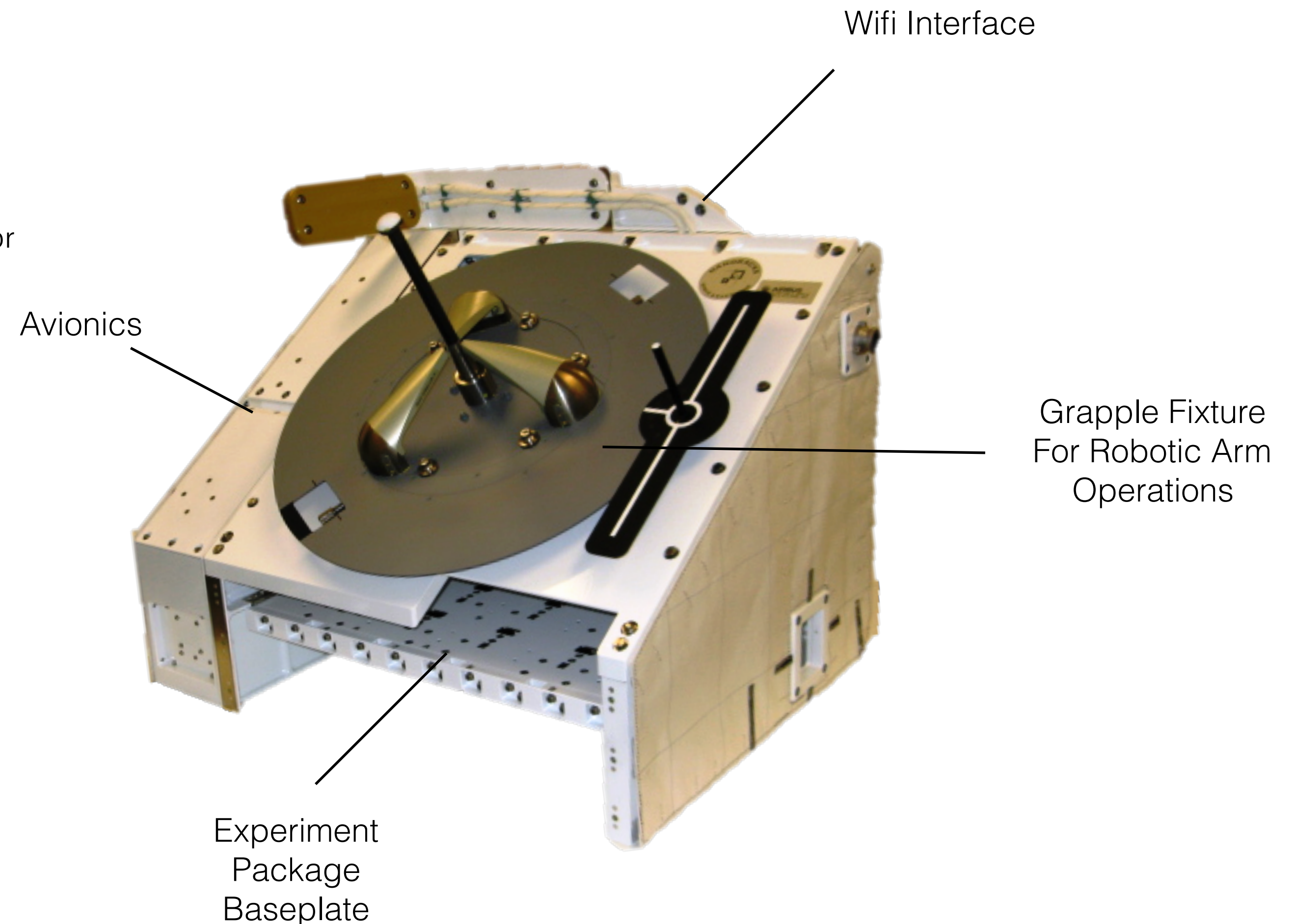
LAUNCHED TO ISS ON HTV-5- AUGUST 2015

ALTERNATIVE TO FREE FLYERS

- Platform placed on the exterior of the ISS to provide convenient access to space environment
- First mission deployment in August 2016
- Serves technology developers, aerospace companies, and government entities for in-space technology validation and commercial endeavors such as space situational awareness

Standard payload provisions

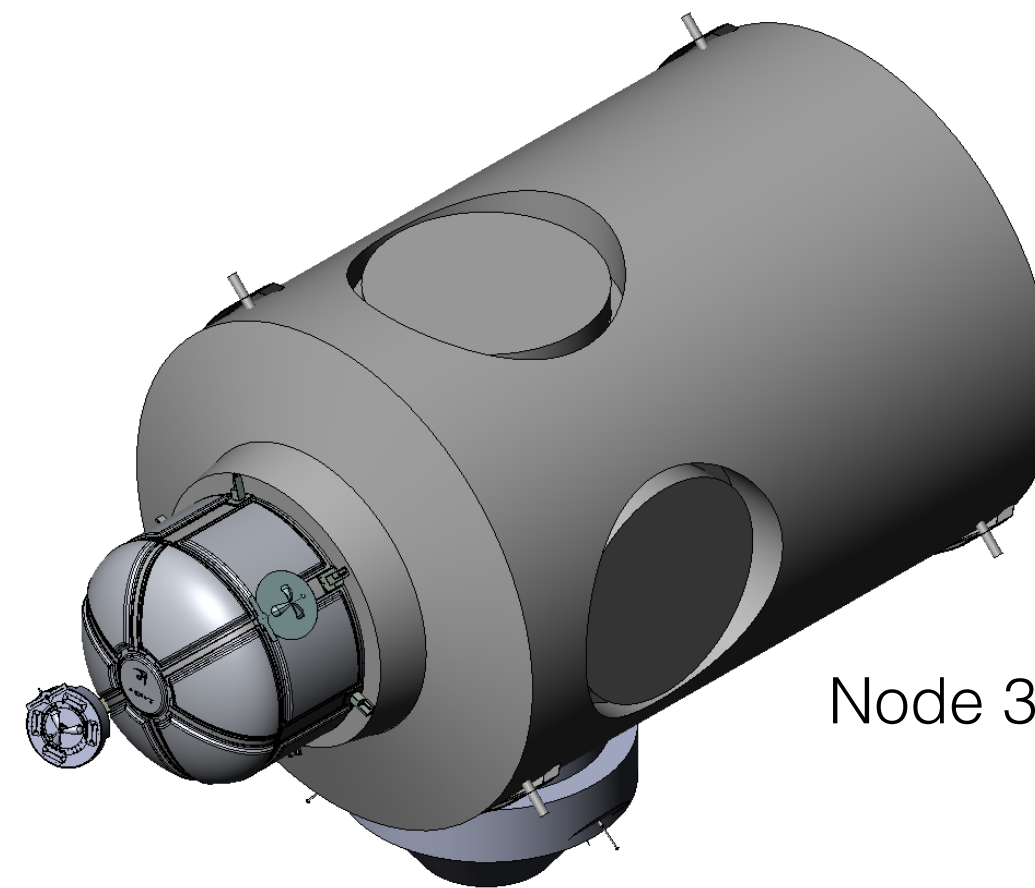
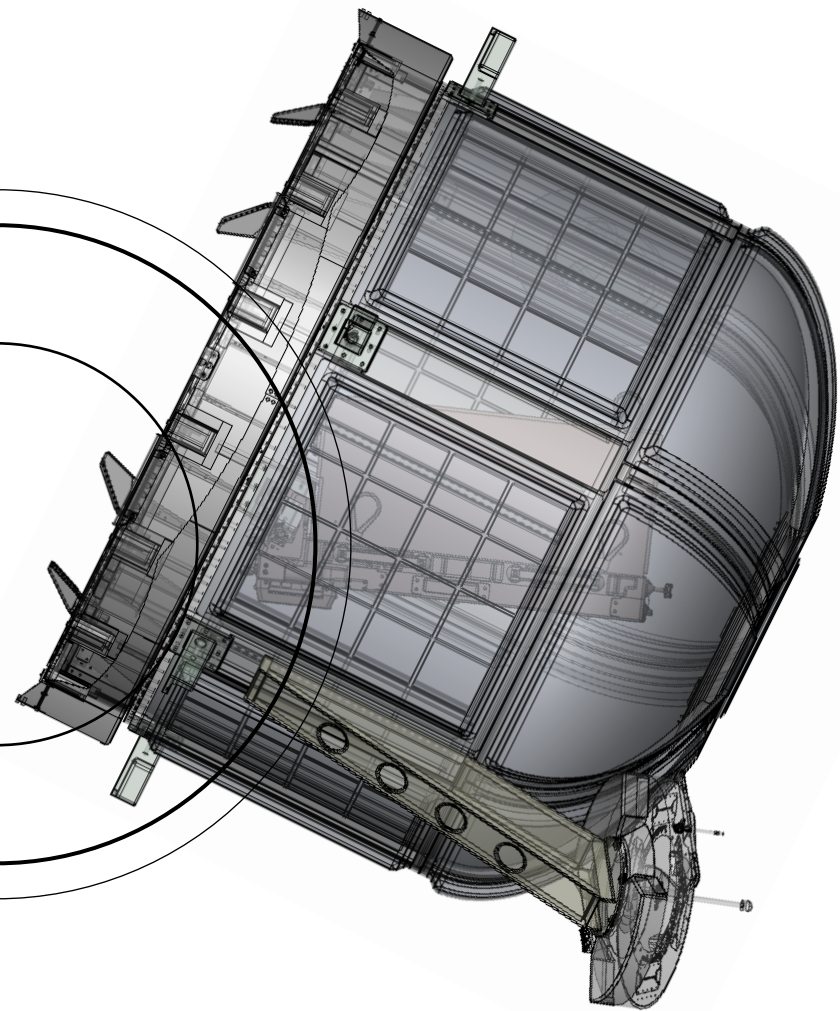
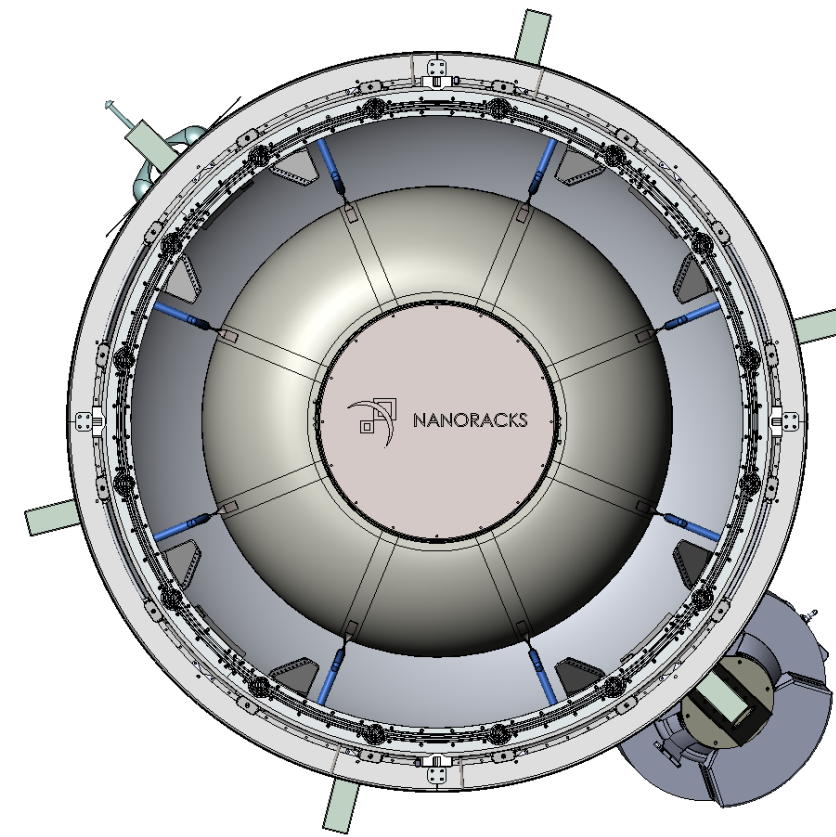
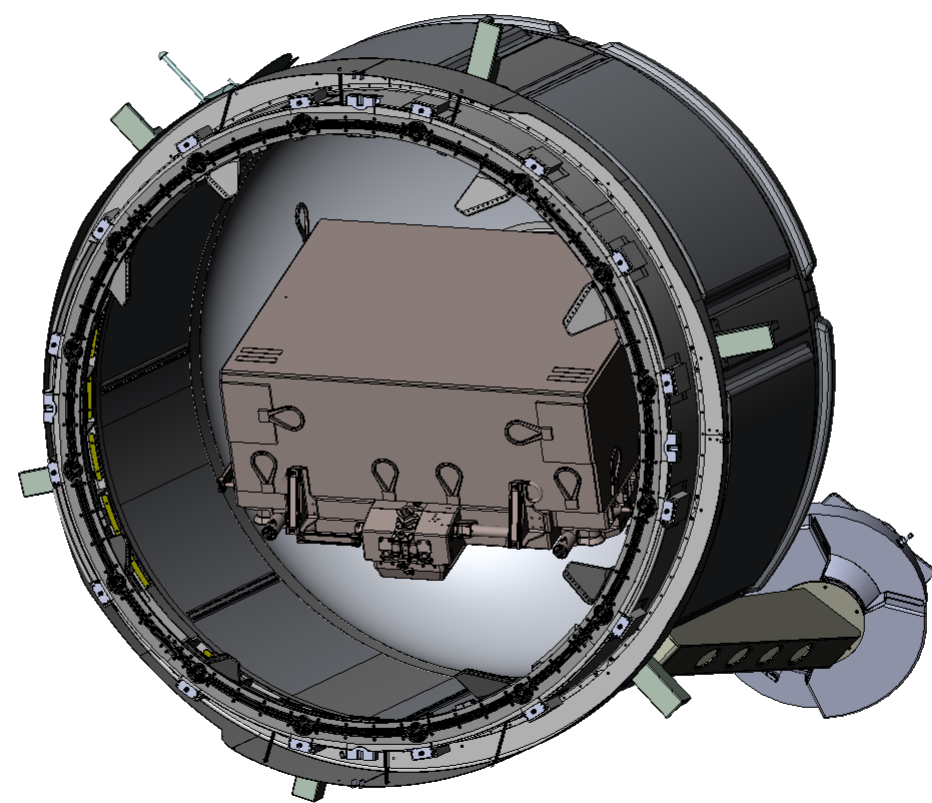
Voltage	28 Vdc +/- 2 V or 120 Vdc as option
Total power	30 W at 28 Vdc
Maximum current	2A
USB 2.0 bus	5 Vdc/ 500mA non-switchable
Total payload data rate	Up to 8 Mbit/s



NANORACKS AIRLOCK

IMPLEMENTATION

NANORACKS' COMMERCIAL AIRLOCK, will supercharge the satellite deployment business and open up new, lucrative business lines. Built as a pressurized teapot dome attached to the side of the ISS, The Airlock will be able to deploy large numbers of satellite, small and large, at a pace and schedule un-hindered by the many restrictions on NanoRacks' current deployer systems



THE IMPORTANCE OF THE AIRLOCK IS:

- Maximum operational flexibility, more control over deployments
- Greater capacity - multi-satellite deployments and Large satellite deployments
- Stepping stone to use of platforms outside of ISS
- Additional capacity for External Platform customers
- Station equipment repair

WHAT ARE OUR CUSTOMERS UP TO?

THEY'RE ALL AROUND THE WORLD



Our customers include everyone from high schools to government space agencies, all who pay for our services on a commercial basis. The client base includes commercial companies, VKI, ESA, NASA, NRO, DoD, and dozens of high schools and universities. Our customer base is thoroughly international, with companies and organizations from Romania to Israel, from Peru to Saudi Arabia, as well as a full range of government and private customers from the United States.

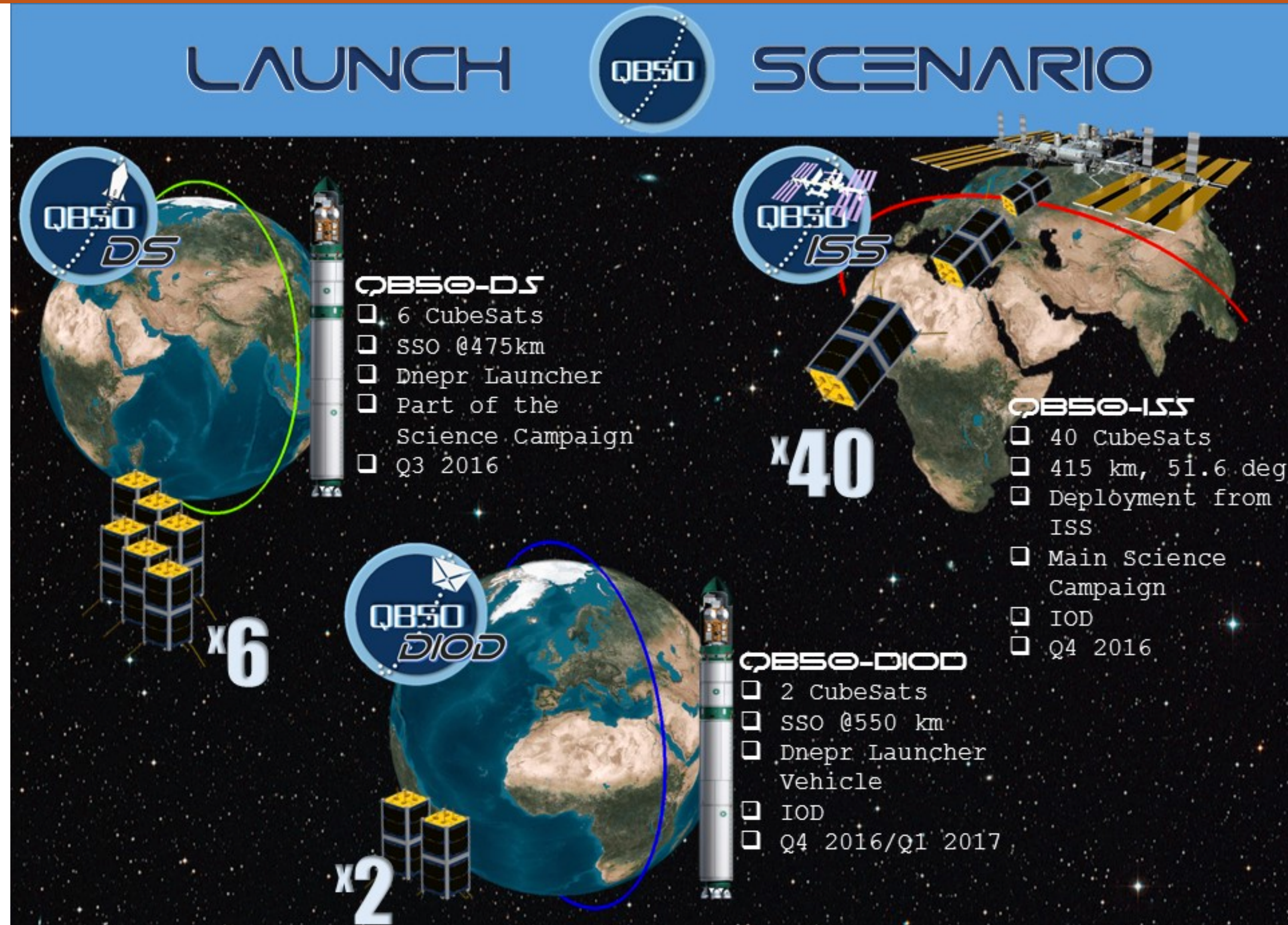
- NanoRacks is accommodating customers from both the private and public sectors who are looking to expand their commercial business ventures as well as demonstrate future technologies.
- Highlights include:
 - CubeSat tracking
 - Deployment of 100 nanosatellites
 - Propulsion systems
 - Formation flying
 - Reentry experiments
 - QB50



QB50

NANORACKS CHOSEN AS DEPLOYMENT AND LAUNCH SERVICES PROVIDER

- The QB50 mission will demonstrate the possibility of launching a network of 50 CubeSats built by Universities Teams all over the world as a primary payload on a low-cost launch vehicle to perform first-class science in the largely unexplored lower thermosphere.
- One of the main purposes of the QB50 project is to achieve a sustained and affordable access to space for small scale research space missions and planetary exploration.
- QB50 will make use of three different launch campaigns to complete the orbital injection of all the CubeSats. NanoRacks was selected as the deployment provider for the ISS launch scenario, utilizing the NRCSD.
 - 6 CubeSats launched on a “Dnepr Science Flight”, QB50-DS
 - 40 CubeSats deployed from the ISS, QB50-ISS
 - 2 IOD CubeSats launched on a second Dnepr, the “Dnepr IOD Flight”, QB50-DIOD



DEPLOYING IN 2016

NANORACKS CUSTOMERS

CUBESATS

CADRE: University of Michigan

MinXSS: University of Colorado

STMSat: St. Thomas More Cathedral School

KickSat-2: Cornell University

NODeS: NASA Ames

TechEdSat-5: NASA Ames

SGSat: University of Kentucky

Doves: Planet Labs

ALTAIR-1: Millennium Space Systems

NREP

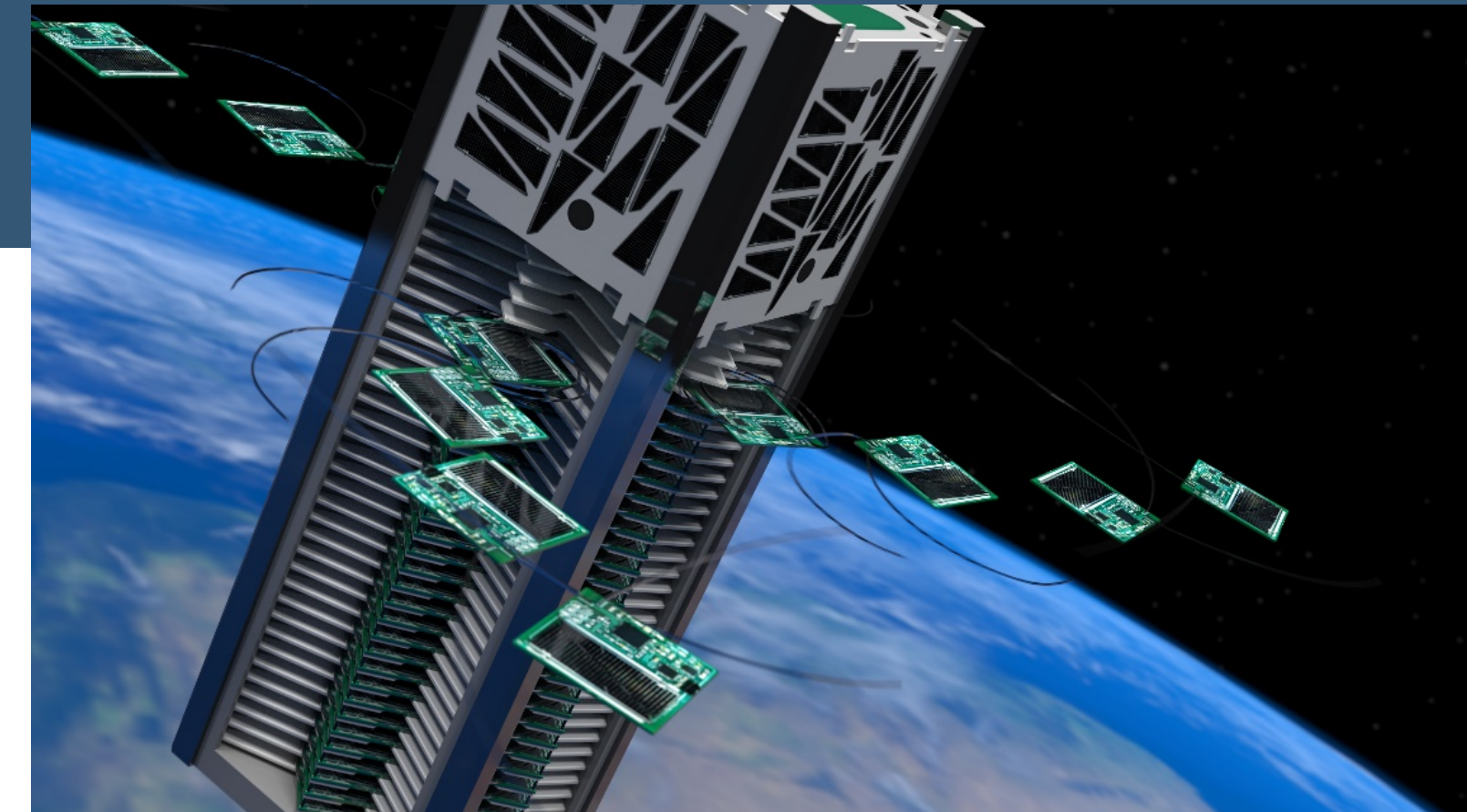
Gumstix: Yosemite Space

NanoTube Solar Cells: Georgia Tech

DM: Honeywell Aerospace and Morehead State University

CID: Florida Institute of Technology

A-76: A-76 Technologies



THANKS!

ANY QUESTIONS?

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